second laser pulses with a constant amplitude for investigating the interaction of laser and electron beams. A phosphate-glass laser of this type was developed in the P N Lebedev Physics Institute, Russian Academy of Sciences. The radiation stabilization and the generation of constant-amplitude subpicosecond laser pulses are attained through the use of an external optoelectronic negative-feedback system [16]. Schematic of the laser and its parameters are given in Fig. 7. The energy of a single pulse ranges from 0.1 to 1 μJ. Reaching the parameters specified in Section 2 requires multiplication by a factor of $10^3 - 10^4$; in this case, the total pulse train energy will be as high as 10 – 100 J, which appears to be quite realistic. In this case, the X-ray pulse train will contain $\sim 10^{11}$ photons, which will make it possible to record high-contrast images with up to 10^6 pixels in a time ~ 1 ms.

4. Conclusions

Hence, state-of-the-art laser and accelerator technologies allow us to raise the question of the development of qualitatively new means of X-ray diagnostics, which can find application in different fields of medicine. In essence, the employment of a laser in lieu of magnetic undulator systems enables us to reduce the energy and dimensions of electron storage rings which generate X-ray radiation. The prospect of elaborating compact laser electron-beam X-ray sources attracts the attention of many scientific groups [18 – 21] worldwide due to the indisputable advantages over both X-ray tubes and synchrotrons. Among the applications, the emphasis is put on medicine, though others exist in non-destructive testing and security systems. The highly practical significance of these fields and the growing demand for new equipment are good spurs for the development of laser electron-beam X-ray radiation sources.

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Cosmological model and universe structure formation

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The development, on the one hand, of new methods and technologies of measuring the anisotropy and polarization of relict radiation and, on the other hand, the elaboration of maps of large-scale visible-matter distribution in the Universe have led to the experimental determination of the cosmological model, which physicists and astronomers of the 20th century could only dream of. For the first time, the spatial spectrum of primary cosmological density perturbations has been measured on scales of length ranging from clusters (~ 10 Mpc) to superclusters (~ 300 Mpc) of galaxies at different instants of their evolution: 400 thousand years after the Big Bang ($E \sim 1$ eV) in the epoch of hydrogen recombination observed in the radio frequency band, and for the modern period of cosmological structure formation ($E \sim 10^{-3}$ eV, 13 billion years after the Big Bang) studied on the basis of the distribution of galaxies and their clusters by optical and X-ray astronomy techniques.

Today we can speak about a qualitative breakthrough in observational cosmology: we know the solution to the problem of the gravitational instability of the Universe. Independently reconstructed were the initial conditions (the primary field of cosmological density perturbations) as well as the values of cosmological model parameters, including the composition and quantity of hidden matter (cold particles, baryons, massive neutrinos) and dark energy (the physical vacuum density), which determine the evolution of density perturbations from the recombination epoch to now.